

TITLE

Method and electronic circuit for controlling of a supply voltage of a laser diode

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FIELD OF THE INVENTION

The present invention generally relates to the field of controlling of light sources, and more particularly to controlling of a laser diode of an optical reader and/or recorder, such as CD or DVD players and/or recorders.

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BACKGROUND OF THE INVENTION

Typically a laser diode is arranged in a PNP type circuit configuration or, alternatively, in an NPN type circuit configuration. The control of the supply voltage of the laser diode needs to be adapted to the type of circuit configuration which is used, otherwise the lifetime of the laser diode is reduced or the laser diode is even destroyed when the control of the power supply is initialized.

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US Patent number 6,363,044 B1 shows a photo diode detection circuit which is used to automatically identify a type of photo diode circuit connected to it. Once the type of photo diode circuit has been identified by applying a current to it and evaluating a voltage occurring at an input of the detection circuit, the photo detection circuit adapts itself to it, e.g. a reverse biasing voltage is or is not applied to the photo diode of the photo diode circuit. The result is a photo diode detection circuit which uses a forward or a reversed biased photo diode. The photo diode detection circuit is now in a state to measure light falling on the photo diode. The detection circuit is used for monitoring the light intensity of a light source and for a controlling circuit which enables to regulate the intensity of the light source. It is a disadvantage of this prior art controlling circuit that it does not

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automatically adapt to the circuit configuration in which the light source is arranged.

#### SUMMARY OF THE INVENTION

It is an object of the invention to find a solution for a control circuit and method which automatically adapts to the circuit configuration in which a laser diode is arranged.

A solution to the above described problem is provided by applying the features laid down in the respective independent claims. Preferred embodiments of the invention are given in the dependent claims.

The invention enables an effective protection of a light source, such as a laser diode, against application of a wrong supply voltage. It is a particular advantage of the present invention that this accomplished without a need for an extra control pin and without inputting of control information indicating the kind of circuit configuration of the laser diode. Rather the present invention enables to automatically detect the circuit configuration of the laser diode and to initialize the control of the power supply for the laser diode correspondingly.

The present invention is advantageously employed for optical readers and/or recorders such as CD and/or DVD readers and/or recorders.

#### BRIEF DESCRIPTION OF PREFERRED EMBODIMENTS

In the following preferred embodiments of the invention will be described in greater detail by making reference to the drawings in which:

Figure 1 shows a block diagram of an embodiment of an electronic circuit of the invention,

Figure 2 shows a detailed view on the module of figure 1 generating the OUTPOL signal,

Figure 3 is an alternative embodiment of the circuit of figure 2,

5 Figure 4 is illustrative of a signal diagram when the output stage is of the PNP type,

Figure 5 is illustrative of a signal diagram when the output stage is of the NPN type,

10 Figure 6 shows an alternative embodiment of the circuit of figure 1 having an additional detector for the polarity of the measurement signal,

Figure 7 to figure 10 are illustrative of signal diagrams of the preferred embodiment of figure 6

#### DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

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20 voltage Vref1.

Further control circuit 100 has an active off circuitry 104, which comprises two current sources Iu Id as well as switches S31 and S32.

A safety block 106 is coupled to the control circuit 100.  
25 The safety block 106 decides when the laser control switches from the active off phase into the start up phase. The safety block 106 generates an ENABLE signal when the command ON is applied and if the start up condition (external capacitors are de-charged) are fulfilled.

Further there is a safety block 108 which is coupled to the control circuit 100. Safety block 108 serves to determine whether the laser diode which is controlled by the control circuit 100 is in a PNP type or an NPN type circuit configuration. Preferred implementations of safety block 108 are illustrated in figures 2 and 3.

A PNP type circuit configuration 110 having a laser diode 112 or alternatively an NPN type circuit configuration 114 comprising laser diode 116 is connected to the output OUT of control circuit 100. The PNP type circuit configuration 110 is a driver circuit for the laser diode 112 using an PNP transistor type. Likewise the NPN type circuit configuration 114 is a driver circuit for laser diode 116 using an NPN transistor type.

A measurement photo diode 118 is connected to the input IN of the control circuit 100. The photo diode 118 measures the light emission of the laser diode 112 or laser diode 116, respectively. This way a feedback signal is provided to control circuit 100 which forms the basis for controlling the supply voltage for laser diode 112, or laser diode 116.

The voltage control of the control circuit 100 is adapted by the OUTPOL signal delivered by the safety block 108 depending whether PNP type circuit configuration 110 or NPN type circuit configuration 114 is connected to the output OUT of control circuit 100. In particular the polarity of the comparator 102 and also the active OFF circuitry 104 is adapted accordingly depending on the OUTPOL signal. The operation of the control circuit 100 has several operation modes:

- active OFF

The external capacitance of the PNP type circuit configuration 110 or the NPN type circuit configuration 114 is de-charged, so that the laser diode 112 or 116, respectively is OFF. This is a safety requirement in order to avoid destruction of the expensive laser diodes 112 or 116.

- active ON

The laser control is switched off when the start up phase is entered. During the start up phase safety functions are checked and the external capacitors are charged.

- control phase

When all safety checks have been fulfilled the control circuit 100 enters the control phase. The laser diode light emission is regulated based on the reference voltage  $V_{ref1}$ .

Figure 2 is illustrative of an implementation of the safety block 108. Figure 3 is illustrative of an alternative implementation of the safety block 108 which is preferred to the implementation of figure 2. The INIT block generates a pulse of about 100 nanoseconds pulse length when the supply voltage has reached its nominal value. With this pulse the OUTPOL signal is set to a default setting. For example the default setting is  $OUTPOL = 1$  which means that the PNP type circuit configuration 110 (cf. figure 1) is the default circuit configuration. Alternatively the NPN type circuit configuration 114 can be chosen as a default configuration.

Figure 4 is illustrative of the initialization of the control of the supply voltage depending on the type of circuit configuration. In the embodiment of figures 4 and

5, it is assumed that the default setting is OUTPOL = 1, which means that PNP type circuit configuration 110 is the default circuit configuration.

Figure 4 shows the signal diagram if the circuit configuration of the laser diode is indeed of the PNP type circuit configuration 110.

During the active OFF phase the supply voltage at the output OUT is gradually increased towards the reference voltage  $V_{refnpn}$  of the PNP type circuit configuration 110 (cf. Fig. 1). At the same time the measurement signal applied at the input IN is monitored. As the measurement signal applied at the input IN does not show a peak this means that the assumption that the laser diode is in the PNP type circuit configuration 110 is correct and that the polarity of the signal OUTPOL does not need to be changed from the default setting. After the active OFF and the start up phase, the control operation for controlling the supply voltage starts.

Figure 5 shows a corresponding signal diagram when the output circuit configuration is not the default PNP type circuit configuration but an NPN type circuit configuration. Again the supply voltage at the output OUT of the control circuit is gradually increased towards the reference voltage  $V_{REFPNP}$  of the PNP type circuit configuration 110 as the PNP type circuit configuration is the assumed configuration. As the laser diode is in fact arranged in an NPN type circuit configuration application of the gradually increasing supply voltage results in the emission of light from the laser diode and thus in a peak of the measurement signal applied at the input IN.

In response to the peak 120 the polarity of the OUTPOL signal is changed from 1 to 0 and the direction of change of the supply voltage signal at the output OUT is likewise changed into the direction of the voltage reference Vrefnpn of NPN type circuit configuration 114.

Figure 6 shows a block diagram of an extended embodiment based on the embodiment of figure 1. In the embodiment of figure 6 there is photo diode detection circuit 122 between the input IN and the input of control circuit 100. Preferably photo diode detection circuit 122 is designed in accordance with US patent number 6,363,044B1, which is incorporated herein by reference in its entirety.

Due to the photo diode detection circuit 122 it is possible to either use photo diode 118 or reverse biased photo diode 124. In either case the photo diode detection circuit 122 will deliver the same signal INCOMP for inputting into the comparator 102 of the control circuit 100 (cf. figure 1).

As apparent from the signal diagrams of figures 7 to 10, the operation of the control circuit 100 is the same irrespective of whether photo diode 118 or photo diode 124 is used. Figure 7 shows the signal diagram where the laser diode is arranged in the default PNP type circuit configuration and diode 118 is used. Figure 8 shows the situation where diode 124 is used. In this instance the polarity of the INPOL signal is changed, such that switch S5 of photo diode detection circuit 122 (cf. figure 6) is switched from its '1' to its '0' position.

Figures 9 and 10 show the corresponding signal diagrams for a laser diode being arranged in an NPN type circuit configuration.